CLAIMS

1. An ultrasonic emitter comprising a resonant unit including an active element having a front surface facing in a forward direction and having a rear surface facing in a rearward direction, said active element being operative to generate ultrasonic vibrations in response to an applied signal, said resonant unit including a liquid disposed to the rear of said active element, said resonant unit being resonant at an ultrasonic frequency and adapted to emit ultrasonic vibrations at said ultrasonic frequency principally in said forward direction.

2. An ultrasonic emitter comprising:

(a) an active element having front and rear surfaces, said active element being operative to generate ultrasonic vibrations in response to an applied signal;

(b) a rear structure defining a space disposed to the rear of said active element,; and

(c) a liquid in said space,

said element, said rear structure and said liquid cooperatively forming a resonant unit, said resonant unit including a backing interface said element, said liquid being disposed between said backing interface and said rear surface of said active element.

3. An ultrasonic emitter comprising:

(a) an active element having front and rear surfaces, said active element being operative to generate ultrasonic vibrations in response to an applied signal;

(b) a rear structure defining a space disposed to the rear of said active element,; and

(c) a liquid in said space,

said active element, said rear structure and said liquid cooperatively forming a resonant unit, said resonant unit including a backing interface, said liquid at least partially defining said backing interface.

4. An emitter as claimed in claim 2 or claim 3, further comprising a source of liquid communicating with said space and an outlet communicating with said space, said source being operative to move said liquid through said space.

5. An emitter as claimed in claim 2 or claim 3, wherein said active element bounds said space whereby said liquid in said space is in contact with said active element.

6. An emitter as claimed in claim 3, wherein rear structure includes a solid wall disposed to the rear of said space, said wall having acoustic impedance differing from the acoustic impedance of said liquid, said wall and said liquid cooperatively defining said backing interface.

7. An emitter as claimed in claim 2 or claim 3, wherein said rear structure includes a wall having a front surface facing toward said space and a rear surface facing away from said space, and a medium having acoustic impedance lower than the acoustic impedance of said liquid, said medium abutting said rear surface of said wall.

8. An emitter as claimed in claim 7, wherein said medium is a gas.

9. An emitter as claimed in claim 2 or claim 3, wherein said active element is a piezoelectric element.

10. An emitter as claimed in claim 9, wherein said piezoelectric element includes electrodes at said front and rear surfaces.

11. An emitter as claimed in claim 2 or claim 3, wherein said active element is generally tubular, said front surface of said active element facing to the outside of the tubular element, said space and said reflective interface being disposed within the tubular element.

12. An ultrasonic emitter comprising:

(a) a tubular piezoelectric element having an interior bore, an inner surface bounding said bore and an outer surface;

(b) an interior structure extending within said bore, said interior structure including a first tube substantially coaxial with said tubular piezoelectric element so that said first tube and said piezoelectric element cooperatively define an annular passageway therebetween;

(c) a gas disposed within said first tube; and

(d) means for connecting the annular passageway to a source of a liquid.

13. An emitter as claimed in claim 12 further comprising a sealing structure at least partially sealing said first tube and confining said gas within said first tube.

14. An emitter as claimed in claim 12 further comprising a second tube substantially concentric with said first tube, said first and second tubes cooperatively defining an annular gap therebetween, said gas being disposed in said annular gap.

15. An emitter as claimed in claim 12, wherein said first tube is formed from a metal.

16. An emitter as claimed in claim 12, wherein said tubular piezoelectric element includes a ceramic piezoelectric material.

17. An emitter as claimed in claim 12, wherein said tubular piezoelectric element has cross-sectional dimensions of 4 mm or less.

18. A method of emitting ultrasound comprising the steps of:

(a) providing a resonant unit including an active element having a front surface facing in a forward direction and a liquid disposed to the rear of said active element, said resonant unit being resonant at an ultrasonic frequency; and

(b) driving said active element at said frequency so as to cause said active element to generate ultrasonic vibrations at said frequency, said resonant unit emitting ultrasonic vibrations principally in said forward direction.

19. A method as claimed in claim 18 further comprising the step of replacing said liquid during said driving step so that said liquid flows through said resonant unit and said liquid removes heat from said active element.

20. A method as claimed in claim 19, wherein said liquid is in contact with said active element.

21. A method as claimed in claim 18, wherein said resonant unit includes a reflective backing interface, said liquid being disposed between said reflective backing interface and said rear surface of said active element.

22. A method as claimed in claim 21, wherein said reflective backing interface includes a gas, said liquid being disposed between said gas and said rear surface of said active element.

23. A method as claimed in claim 18, wherein said resonant unit includes a reflective backing interface, and said liquid forms part of said reflective backing interface.

24. A method of emitting ultrasound comprising the steps of:

(a) driving an active element having front and rear surfaces at an ultrasonic frequency so that said active element generates ultrasonic vibrations at said frequency;

(b) passing a liquid through a space between the rear surface of the active element and an acoustically reflective interface so that said liquid removes heat from the active element and so that ultrasonic vibrations propagated from the rear surface of the active element pass through the liquid to the reflective interface, are reflected at the interface and pass back through the liquid to the active element, said reflective interface backing said element and directing the ultrasonic vibrations out of the element substantially through said front surface.